The Half-Life of Am^{243}

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The alpha half-life of Am^{243} was found to be 8800 ± 600 years. The ratio of Am^{243} and Am^{241} masses in the sample was measured with a mass spectrometer, and the ratio of their alpha activities was measured with a differential alpha pulse analyzer. A method for preparation of thin samples of americium by electrodeposition is described.

STREET, Ghiorso, and Seaborg[1] determined a rough half-life of about 10^4 years for Am^{243} from a measurement of the amount of Np^{239} daughter in equilibrium with Am^{243}. A more accurate determination has become feasible with the acquisition of an Am^{243} sample formed in plutonium that had been extensively irradiated in the Chalk River pile.[2] The sample was chemically purified, and the mass ratio of Am^{243} to Am^{241} determined accurately with the 60°, 12-inch radius mass spectrometer, using a multiple-filament ionization source. The ratio of the alpha activities of the americium isotopes was measured with a differential alpha pulse analyzer. From these data and the known Am^{241} half-life,[3] the Am^{243} half-life was calculated.

EXPERIMENTAL

Americium, curium, and most of the fission products were separated from the bombarded plutonium by elution from an ion exchange column. Further purification from fission products was obtained by elution from two successive Dowex-50 cation exchange columns with concentrated HCl.[4] This was followed by two successive cation exchange columns of Dowex-50 at 87°C, using 0.25 M citric acid whose pH had been adjusted to 3.5 with NH_3, as the eluant.[5]

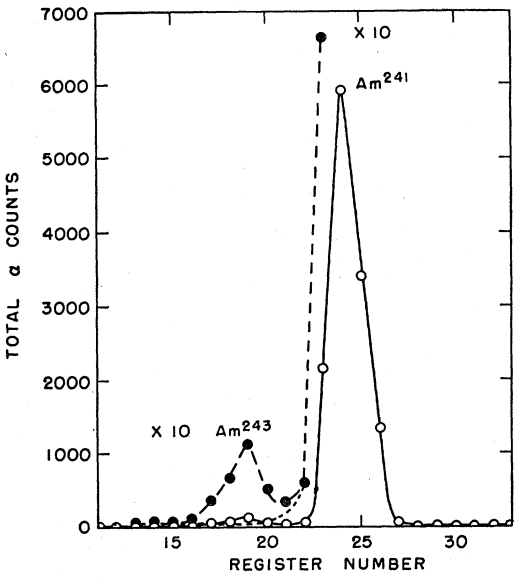

FIG. 1. Typical pulse analysis of americium fraction.

The americium and curium fractions were combined, and the mole ratio, $Am^{243}:Am^{241}=0.335\pm0.003$, was determined by mass spectrometer. The absence of fractionation of the 243 mass peak with respect to the 241 peak over a wide range of electrode temperatures, indicated that these masses were due to the same element.

Accurate pulse analyses of the americium required the removal of the curium activity. This was accomplished by three successive oxidation-reduction cycles,[6] using LaF_3 as a carrier. Three such cycles resulted in a 10^4-fold separation of americium from curium. In order to obtain the americium free from carrier and from fluoride, zirconium hydroxide was substituted for LaF_3 as a carrier, and the zirconium finally removed by thenoyltrifluoroacetone (TTA)-benzene solvent extraction.[7]

A thin, uniform deposit suitable for pulse analyses was obtained by electroplating the purified americium from 10 ml 0.2 M K_2CO_3 in a cell similar to the one described by Hufford and Scott.[8] The anode was a rapidly rotating carbon rod, 6 mm in diameter; the cathode was a tantalum disk, 2 cm in diameter; the emf was 11 volts; and the current 90 to 120 milliamperes. After electroplating for 100 minutes at room temperature, the cell was disassembled, and the cathode washed rapidly with dilute NH_4OH and water. The yield was about 60 percent.

The average alpha activity ratio of 5.27-Mev Am^{243}

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[5] The authors wish to acknowledge the aid of the Health Chemistry Group of the University of California Radiation Laboratory, Berkeley, California, under the direction of N. B. Garden and William G. Ruehle. This group designed and operated the remote control equipment used in the initial separations at Berkeley.
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[7] R. E. Connick and W. H. McVey, J. Am. Chem. Soc. **71**, 3182 (1949).
[8] D. L. Hufford and B. F. Scott, Atomic Energy Commission Report MDDC-1515, 1945 (unpublished).

to Am^{241}, from five pulse analyses, was 0.0179±0.0006 (Fig. 1).

RESULTS

The alpha half-life of Am^{243} was calculated from these data to be $(8.8\pm0.6)\times10^3$ years, using 470_{-10}^{+5} years as the half-life of Am^{241} [3] and assuming that there is no alpha fine structure of Am^{243} that might be obscured by Am^{241} alphas. The error reported is based upon standard deviation of the alpha counting data (3 percent), the mass spectrometer error (1 percent), the error in the half-life of Am^{241} (2 percent), and the estimated error due to the uncertain correction for the Am^{241} alphas in the Am^{243} peak.

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Spin-Orbit Coupling Energy in O^{17}†

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A proportional counter filled with carbon dioxide was irradiated with monoenergetic fast neutrons produced by bombarding thin lithium targets with protons from an electrostatic generator. Angular distributions of neutrons scattered by oxygen were deduced from the energy spectrum of recoil oxygen ions for neutron energies from 392 kev to 1412 kev, determining the parities of three spin-$\frac{3}{2}$ levels in O^{17}, 4.56, 5.08, and 5.39 Mev above the ground state. The 5.08-Mev state has even parity and appears to be the $D_{\frac{3}{2}}$ member of a $D_{\frac{5}{2}}-D_{\frac{3}{2}}$ doublet, where the $D_{\frac{3}{2}}$ level is then 5 Mev higher than the $D_{\frac{5}{2}}$ ground state of O^{17}. The other two states have odd parity and lie more than 1.5 Mev above the lowest spin-$\frac{1}{2}$ odd-parity level. This may indicate a spin-orbit splitting of the order of 2 Mev or greater in the P shell.

I. INTRODUCTION

IT might be hoped that the examination of the states of nuclei made up of a closed shell plus one "outside" nucleon would result in information which could be interpreted to help determine the source and strength of spin-orbit forces in nuclei. Various results pertaining to the spin-orbit splitting of the P states of a single nucleon outside the closed 1 S shell, that is, states of He^5 and Li^5, appear to be inconsistent and therefore inconclusive.[1] The next heavier closed shell plus one nuclei are the isobaric $O^{17}-F^{17}$ pair. According to the ordering of levels in a potential well, the lowest state of these nuclei should be either a $2S$ or $1D$ state, the integer representing the number of nodes in the radial wave function. Alder and Yu[2] have shown that the spin of the ground state of O^{17} is $\frac{5}{2}$, and it can be concluded that this state is primarily $D_{\frac{5}{2}}$, a hypothesis in good agreement with the electric quadrupole[3] and magnetic dipole[2] moments. It might, then, be expected that a $D_{\frac{3}{2}}$ state of O^{17} should exist and lie at an excitation energy determined by the strength of the spin-orbit forces acting on the added neutron. Positions of the low-energy levels of O^{17} are known from a variety of experiments,[4] and the spins and parities of all states below 4 Mev can be deduced[5–7] either from experiments on O^{17} or from measurements pertaining to the mirror nucleus F^{17}. None of these states has spin $\frac{3}{2}$, and there is no reason to believe such a state would have been missed because of selection rules or experimental limitations. However, three spin-$\frac{3}{2}$ states are known[8] between 4.5 and 5.4 Mev, and it seemed probable that one of these was the $D_{\frac{3}{2}}$ member of the doublet including the ground state. It was the purpose of these measments to determine the parity of these levels in the hope of finding the $1D_{\frac{3}{2}}$ state in O^{17}, and thus to obtain a measure of the spin-orbit splitting in the $1D$ shell.

II. THEORY OF THE MEASUREMENTS

The variation of total neutron cross section with energy at an elastic scattering resonance associated with a state of spin J is $[(2J+1)/(2I+1)]2\pi\lambda\!\!\!^{-2}$, where I is the spin of the target nucleus, a result independent of the parity of either the target nucleus or the resonance level. Total cross-section measurements interpreted in this way were used to assign values of $\frac{3}{2}$ to the spin of levels in O^{17} at excitation energies of 4.56, 5.08, and 5.39 Mev.[8] If there is no interference between a resonant state and other states, the differential cross section for neutron scattering will also depend solely on J and I. However, an interpretation of the observa-

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